Correlations between classroom environmental noise and teachers' voice

Correlações entre ruído ambiental em sala de aula e voz do professor

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ABSTRACT

Purpose: To explore the existence of correlations between environmental noise in classrooms, voice intensity and teacher's vocal problems. **Methods:** Environmental noise was measured in 10 classrooms of municipal elementary schools; the intensity of teachers' voice was measured during teaching practice; teachers' speech samples containing emissions of sustained vowel [é] and counting from 1 to 20 were analyzed using the GRBASI protocol; and the results were tested for correlation. **Results:** The average of environmental noise varied from 40 to 51 dB(A) without the presence of children in the classroom, and from 45 to 65 dB(A) with the presence of children. Among teachers, there was 70% of vocal problems (G) and 90% of vocal strain (S) varying from moderate to mild degrees. The intensity of teachers' voice varied from 52 dB(A) to 68 dB(A), reaching 7.48 dB(A) above the environmental noise. There was a significant correlation between the intensity of teachers' voice and the environmental noise during the class in the presence of children. **Conclusion:** There were high levels of environmental noise in the classrooms, which correlated with the intensity of teachers' voice (SPL). Although there was high occurrence of vocal problems in this sample, they were not correlated with the level of environmental noise.

Keywords: Voice; Noise; Faculty; Dysphonia; Auditory perception

INTRODUCTION

Concern with work environment and its relation with health are not recent. Noise pollution has increasingly become a huge problem, requiring actions and ways of control to reduce its harmful effects in all instances and to improve health conditions of the population.

The Brazilian Association of Technical Standard (ABNT), through the Registered Brazilian Standard NBR 10152[1], foresees an acceptable environmental noise in classrooms of 40 to 50 dB(A), with values above this range considered to be harmful to health[2]. Intense noise impairs verbal communication, leading to higher psychological tension and lesser attention levels[3].

Environmental noise exists in schools in different ways: external to institutional buildings, coming from the surrounding streets; external to classrooms, coming from courtyards, corridors, near classrooms, bells and maintenance of buildings; internal to classrooms, caused by children's speech and equipment's noise, such as fans. In the classroom, students may listen to two different sound stimuli: teacher's voice, which should be the main focus of attention; and environmental noise, the competitive signal that should be neglected in order for the main message not to be distorted[4]. The noise that comes from inside the classroom is more likely to be perceived by teachers and students than external noise, which are usually randomly noticed[5]. In disadvantaged acoustic conditions, in which noise intensity masks teacher's voice, the student will find it hard to comprehend the message[6], leading to problems in the process of teaching and learning and causing potential stress to the teacher.

Noisy environment provokes louder speech and the continuity of this context may harm phonation structures and produce vocal problems over time. These problems vary regarding the degree of hoarseness and the presence of lesions in the vocal fold mucus. In this scenario, teacher's work environment may be considered inadequate[7] because several factors inherent to professional practice might raise tension, besides noise itself[8,9]. Among these factors it is possible to identify the lack of information concerning how to produce functional speech in different teaching contexts and life habits developed socio-culturally.

Recently, a Brazilian study showed that 63% of teachers consider hoarseness to pose a negative impact on communication[10]. In another research, the excess of noise was identified by teachers as the cause of competitive sound and vocal efforts[11]. According to the literature, there is high frequency of vocal problems among teachers[12-17], which influences interaction in classrooms and consequently impairs students' attention and their active participation in the learning process[18-21], causing emotional stress to teachers[22].

In this context, teacher's vocal tiredness and signs of vocal effort may be considered risk factors to vocal problems[23]. There is evidence showing that teachers need to raise their voices from 10 to 30 dB(A) above the intensity of environmental noise[5,24]. However, the presence of intense environmental noise, ranging from 56.1 dB(A) to 94.1 dB(A), with mean of 72.7 dB(A) [16,25], was not associated to dysphonia in a group of child educators in the city of São Paulo[16]. Therefore, the relation between noise in classrooms and problems in the learning process is not always valid[5]. This reinforces the need of caution to generalize the correlations between intense noise and vocal problems, because there are individual differences in the way the vocal behavior reacts in response to this context, as detected among Swedish Primary--school teachers[26].

Vocal problems in teachers have wide consequences that may affect their quality of life, reducing social activities and interactions, impairing communication, creating social and emotional problems and even loosing days of work. Absenteeism is negative to work management and lead to learning and economical problems for professionals and education institutions[9].

It is important, therefore, to investigate the teaching work environment in order to identify the risk factors of vocal pro-blems in teachers. Among this factors, it is possible to assess the levels of sound pressure/ noise produced while the teacher is working, and to analyze the association between sound exposure and potential vocal problems[8].

This study had the aim to correlate environment noise in classrooms, the intensity of teachers' voice and the existence of vocal problems in primary-school teachers of the first grade.

METHODS

This research was developed in municipal education institutions in the countryside of the state of São Paulo, with previous formal permission of the managers and written consent of teachers who participated in the study. The project was approved by the Research Ethics Committee of the University Center of Araraquara (UNIARA), through the protocol 809/08.

We analyzed the environmental noise in classrooms of the first grade of primary education. This grade was chosen because it constitutes an important period for formal learning, particularly because of the alphabetization process. It is also known that during this period there is a huge demand of teachers' voice and problems may arise due to environmental noise or vocal problems in teachers.

This study was run in ten classrooms of the first grade, having required the participation of ten teachers. Most classrooms were placed in the urban perimeter, away from the city center. All schools except for three consisted of ground level buildings. Car movement on the streets surrounding the schools varied. All teachers were female, with mean age of 40 years. The researchers observed the school environment during data collection regarding physical characteristics of classrooms, number of students and teacher's vocal behavior, using the same standards for all schools (Chart 1).

Chart 1. Sample characterization

Classroom	Door placed towards:	Windows placed towards:	External noise	Fan	Number of students	Teachers' vocal behavior
1 (ground floor)	Other rooms	Street	Low	Noisy	12	Tried not to shout, sometimes shout because of conversation between students
2 (ground floor)	Other rooms	Other rooms	High	Noisy	21	Calm but showed vocal strain
3 (upper floor)	Other rooms	Street	High	Noisy	17	Spoke softly but sometimes shouted because of conversation between students
4 (upper floor)	Other rooms	Street	Low	Noisy	23	Did not shout too much and appeared to be calm
5 (ground floor)	Courtyard	Street	High	Noisy	28	Spoke loud and showed vocal strain
6 (ground floor)	Vacant lot	Other rooms	Low	Noisy	14	Spoke loud and showed vocal strain
7 (ground floor)	Courtyard	Street and other rooms	Low	Noisy	26	Showed vocal strain
8 (upper floor)	Corridor	Street and other rooms	Low	Noisy	24	Spoke softly
9 (ground floor)	Other rooms	Courtyard	High	Noisy	18	Spoke loud
10 (ground floor)	Library	Street	Low	Noisy	24	Spoke loud

Procedures for collecting and analyzing sound intensity level of noise in classrooms

The investigation of noise level in classrooms was based on the recommendations of the National Standards NBR 10.151[27] e NBR 10.152[1].

We used an Instrutherm® equipment, model Sound Level Meter (SL – 4011), which was properly calibrated. The adjustment criteria were: pondering circuit – "A", response circuit – "slow", and measurement range between 50 and 100 dB(A). The mean of sound pressure level (SPL) was calculated from two measures in three specific locations in the classrooms, adding up six measurements in each class. The measure of sound pressure level was always directed towards the center of the room, one meter above the floor and one meter away from the wall. This procedure intended to avoid standing waves. The precise locations measured in this study were near the blackboard, near the windows and near the door, and for each location we registered the minimum and the maximum intensity of noise and those sounds varying more than or equal to 5 dB(A) during five minutes. The noise was measured in two situations: before the beginning of classes, without students; and during the classes, with the students and the teacher, representing a normal context of teaching activity that was not merely an expositive class. It is important to reinforce that the researcher stayed in the classroom for a longer period than necessary for data collection, in order for the students and teachers to be familiar with the presence of a new person in the room and to reduce any undesirable interference in teaching routines.

Procedures for collecting sound pressure level of teachers' voices

We decided to measure teachers' vocal intensity for one minute of an expositive class. This allowed us to collect this measure during the teaching and learning activity, that is, in the process of direct knowledge transmission. We are aware that measuring teacher's voice for only one minute may bias the analysis, given that teacher's speech varies a lot during the day. Even though, this information is useful and can contribute to enhance knowledge on how teachers use their voice during the classroom.

The same instrument (sound level meter) was used to assess the sound pressure level of teacher's voice. The equipment was placed one meter in front of the teachers, one meter above the floor. This procedure was chosen to favour the main sound source – the teacher's voice – rather than the environmental noise. We took notes of all kinds of SPL variations (minimum, maximum and those varying more than or equal to 5 dB(A)).

Procedures for collecting and analyzing the sample of teachers' voices

Teachers were assessed in the classrooms, without any students, in two different conditions: sustained emission of the vowel [é] and counting (from one to 20) with natural voice. We used a Panasonic® digital recorder, model RR-US 450, with embedded microphone placed 10 cm away from the mouth in acute angle. We opted for a good but not professional digital recorder because of practical issues concerning data collection. When properly placed, this equipment is able to record speech with good signal and little distortion, despite of the risk to exposure to acoustic noise in the environment.

Digital speech samples were reproduced with earphones and perceptual-auditorily analyzed by three speech-language pathologists with expertise in voice. Voices were classified according to the GRBASI protocol for assessing dysphonia[28,29]. This protocol involves the following parameters: Grade (G), Roughness (R), Breathiness (B), Asthenia (A), Strain (S) and Instability (I), each with four possible scores: 0 (no problems), 1 (mild problems), 2 (moderate problems) and 3 (extreme problems). Although all parameters were assessed, we opted to use only grade (G) and strain (S) for measuring vocal quality.

Grade (G) is the parameter of GRBASI that reflects the general impact of voice, and that is an important reason why it was selected as an important parameter of teacher's voice. Strain (S) was also selected because it was the only parameter scored more than 1 in 40% of the sample. We hypothesized, therefore, that the correlation between S and environmental noise could be significant.

Procedures for data analysis

After data collection, we investigated inter-rater reliability (using Kappa coefficient) among three independent judges concerning each of the six criteria related to teacher's vocal quality. Afterwards, we explored the correlations between environmental noise level, intensity level of teachers' voice and their vocal quality, using Pearson Correlation Test (significance level of 5%). In this way, it was possible to assess whether the variables were related to each other and what was the direction of these correlations (positive or negative). Positive correlation means that when the values of one variable increase, the values of the other variable also increase. Negative correlation, on the other hand, indicates that variables are inversely proportional, that is, an increase in one variable is associated to the decrease in the other variable. Results were summarized in one single table, called correlation matrix, and the values were exhibited in terms of percentage in order to facilitate reading and/or data interpretation.

RESULTS

There was high inter-rater reliability regarding vocal quality (the lowest value was 0.86). Environmental noise in classrooms, in the absence of students, varied from 40.6 to 50.6 dB(A), with mean of 46.08 dB(A). Twenty percent of classrooms (5 and 7) showed SPL of noise above 50 dB(A) (Table 1). When students were in the classrooms, SPL of noise increased, ranging from 45.06 to 65.02 dB(A), with mean of 58.24 dB(A). Nine out of 10 classrooms (90%) exceeded the minimum noise level recommended by the Brazilian Standards NBR 10,152[1], reaching more than 20 dB(A) in classroom 8 (Table 1).

The SPL of teachers' voice varied from 52 dB(A) to 68 dB(A), reaching 7.48 dB(A) above the regular environmental

Table 1. Mean values of environmental noise and degree of vocal problems of teachers.

| Classroom | Mean values – dB(A) | | | GRBASI | | | | | |
	Noise without children	Noise with children	Intensity of teacher's voice	Grade (G)	Roughness (R)	Breathiness (B)	Asthenia (A)	Strain (S)	Instability (I)
1	44.79	45.06	52.54	2	1	0	0	2	1
2	44.8	56.05	60.00	2	1	0	0	2	1
3	44.61	55.88	62.64	2	0	0	0	2	0
4	45.83	60.77	62.07	0	0	0	0	1	0
5	51.52	63.17	68.43	1	1	1	0	1	0
6	41.6	52.03	59.76	2	1	1	0	0	0
7	56.44	56.55	60.00	0	1	0	0	1	0
8	40.66	64.16	64.73	2	1	0	0	2	1
9	45.22	63.73	64.25	0	0	0	0	1	0
10	45.31	65.02	62.53	1	1	0	0	1	1
Mean	46.08	58.24	61.70						

noise (measured during the classes). Data from the perceptual-auditory assessment of teachers' voice indicated that 50% showed moderate vocal problems (G_2) and 20% had mild problems (G_1). Vocal strain was detected in the majority of the teachers, with 50% of mild degree and 40% of moderate degree (Table 1).

We tested then for correlations between SPL of teachers' voice and environmental noise (SPL), with and without children in the classrooms (Figure 1). Although the assessments were carried out in different moments, there was a positive correlation between vocal intensity and environmental noise during classes, in the presence of students (Table 2 and Figure 1).

No correlations were found, however, between teacher's vocal quality, vocal intensity (SPL) and the variables related to the noise in the classrooms (SPL).

Table 2. Correlation matrix – vocal intensity and environmental noise

		Environmental noise with children
Environmental noise without children	Correlation	6.7%
	p-value	0.855
Intensity of teachers' voice during the classes	Correlation	87.2%
	p-value	0.001*

* Significant values (p<0.05) – Pearson Correlation Test

DISCUSSION

This study assessed ten classrooms of the first grade of Primary Schools. Although one can consider the sample to
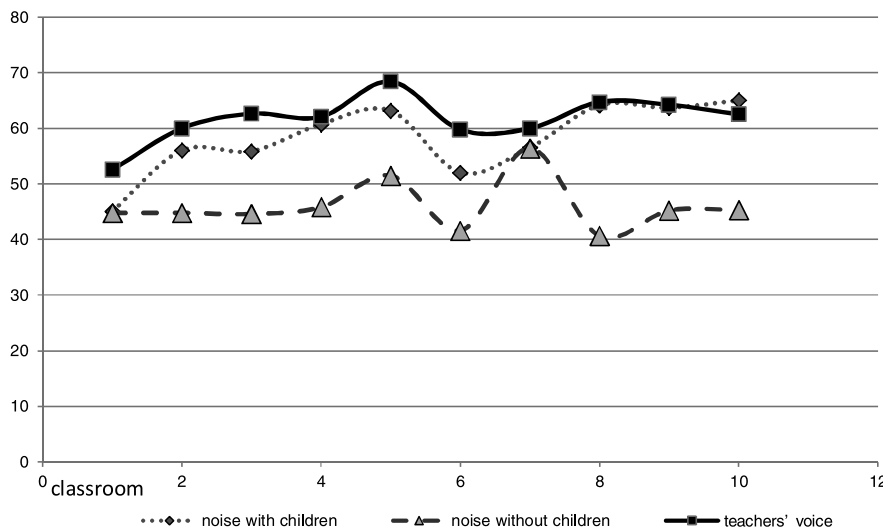

Figure 1. Noise values distribution in classroom and intensity of teachers' voice.

Table 3. Correlation matrix – environmental noise, vocal intensity, general grade of vocal problems and vocal strain

		G (≥1)	S (≥1)
Noise in the classroom with children	Correlation	-46.1%	-14.4%
	p-value	0.180	0.691
Intensity of teachers' voice	Correlation	-29.1%	-19.5%
	p-value	0.414	0.589

Pearson correlation test (p<0.05)
Note: G = general grade of vocal problems; S = vocal strain

be small, as it is the case of previous researches[6,8], this study brings out particular data from municipal schools of the countryside of São Paulo.

Regarding environmental noise, in both conditions analyzed in this study, there was an increase of noise levels in the presence of students. The observation *in locu* revealed the multifactorial nature of sound sources in classrooms, such as student's conversation and disturbance, noise produced by fans that are working during the classes, people walking on the corridors, courtyard and other classrooms while classes are taking place. These factors contribute to environmental noise in classrooms, making the student vulnerable to a series of stimuli other than teacher's voice[4,5], which may cause inattention. This happened mainly in classrooms 1 and 3.

The classrooms 5 and 7 presented the highest mean levels of environmental noise (SPL) without students, although this was not the case for conditions in which children were present. Students in these classrooms may probably use different attention strategies to listen to the teacher even with intense environmental noise[4]. On the other hand, it is likely that teachers have a better control over their students in these classrooms, aiming to facilitate attention in the classroom and to stimulate an active attitude on learning processes[21], focusing their voice as an important resource on learning process[19].

The results related to mean values of environmental noise were similar to those obtained in previous studies conducted inside the classrooms, in which high noise levels were detected (ranging from 56 dB(A) to 94,1 dB(A))[5,16,24]. Therefore, it is suggested that the managers of these schools should act preventively in order to reduce discomfort and promote ideal conditions of teaching-learning.

Most teachers who participated in this study speak competitively to noise in a positive relation (speech/noise) up to 7.73 dB(A). No other studies employed the same methods of this research in order to allow comparisons, but it is still possible to make pertinent considerations. First, the positive value of 7.73 d(A) referent to speech/noise relation is higher than the levels reported in a similar study that analyzed the intensity of teacher's voice in silent contexts rather than *in loco*[24]. Another important issue concerns the lack of studies with similar approaches. In 15 years, only 1,9% of Brazilian studies on teacher's voice were conducted inside the classrooms and none assessed environmental noise or vocal loudness of teachers during professional practice[30]. It is possible to suggest that the challenges of measuring vocal intensity *in loco* need to be disentangled in order to develop this kind of research, given that it is more difficult to obtain a reliable measures of vocal behavior.

In this study, the SPL of teacher's voices was measured in combination to the SPL of noise that is inherent to classrooms. However, because the microphone was placed one meter away from the teacher and their voice was louder than background noise, one might conclude that teachers' vocal intensity was not masked, despite of its possible influence on estimation of correlations.

Finally, although the correlation between noise levels and the intensity of teacher's voice has been positive, that is, the more the noise level, the more the intensity of teacher's voice, this has not prevented teachers to be clearly understood by their students. For this purposes, teacher's voice should be at least 10 dB(A) louder than environmental noise levels[20].

In this context, the fact that teachers increased the intensity of their voices below expected levels for facilitating comprehension by students have different possible interpretations. First, it is difficult to correlate vocal problems and noise due to the fact that lots of participants in this sample showed vocal problems. Second, it is possible that teacher's awareness of vocal behavior that is harmful to health might have prevented them to increase the intensity of their voices enough to create a positive and necessary speech/noise relation. Finally, we can raise the possibility that teachers from this sample were not able to increase their voice in response to the increase of environmental noise[7,10,26], because of potential difficulties in phonation. This would deserve deep investigation, particularly for preventing the development of dysphonia during professional practice[11].

It is known that the competition between voice and environmental noise leads to intense efforts by the speakers to make their selves audible[6]. Researchers discuss the use of this strategy in order to find solutions that create a healthful acoustic environment for the teaching-learning process. Students, and not only teachers, suffer with the presence of noise, showing difficulties to sustain attention, which may cause poor levels of educational achievement[3,6,7,9,15].

We observed a positive correlation between the intensity of teachers' voice and the noise in the classes when students were present, corroborating data from different studies[5,7,13,19,28]. Making a parallel to the school context, one might suggest that the higher the noise in the classroom with students, the louder the voice of teachers (SPL) and vice-versa. Similar findings have been interpreted with caution to establish causal relations between the intensity of teacher's voice and the emergence of vocal problems, because speaking in high intensity for a long period may damage the vocal folds and create different degrees of hoarseness. Therefore, it is essential that teachers from this study are oriented towards how to reduce the level of noise in the classroom and consequently avoid speaking in high levels of intensity that might be prejudicial to voice[7].

As in other studies[14,20,25] there was high incidence of vocal problems in this sample (70%) with great occurrence of moderate impairment. The existence of vocal strain in 90% of the sample indicates that this is one of the most frequent characteristics of the teachers[20]. This finding suggests that teachers, as well as other professionals that use their voice as working tools, should go through regular vocal assessment.

There were no correlations between the quality of voice (presence of vocal problems) and environmental noise, as it was found in a recent study that investigated 27 teachers from different schools of the city of São Paulo[16]. In the current study, we simply identified that those variables were inversely proportional. Thus, the results do not confirm the hypothesis of previous publications[7,11,13,15,25] that claim that the existence of environmental noise may be related to vocal problems in teachers.

It should be reinforced that the context in which SPL was measured in this study and the type of microphone that was used might have biased some correlations. It is also important to consider that the results mentioned in the studies above were obtained through protocols of self assessment and not through perceptual-auditory analysis of vocal samples, carried out by experts. In this sense, it is important that future studies explore cause-effect relations between noise and vocal problems.

CONCLUSION

The findings of this study revealed high levels of environmental noise in the classrooms and positive correlations between those values and the intensity of teachers' voice. There was a high incidence of vocal problems in this sample, which did not correlate with environmental noise levels.

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RESUMO

Objetivo: Identificar se existe correlação entre ruído ambiental no interior da sala de aula, intensidade da voz e presença de alteração vocal em professores. **Métodos:** Foi realizada medição do ruído ambiental em dez salas de escolas municipais de ensino fundamental. A intensidade das vozes das professoras foi medida durante atividade de ensino. Amostras de vogal prolongada [é] e contagem de 1 a 20 emitidas pelas professoras foram analisadas utilizando escala GRBASI. Os resultados obtidos foram correlacionados. **Resultados:** A média de ruído ambiental sem a presença das crianças em sala de aula variou de 40 a 51 dB(A) e com a presença das crianças de 45 a 65 dB(A). Entre as professoras, houve 70% de ocorrência de vozes alteradas no grau geral (G) e 90% com tensão na voz (S), variando entre graus discreto e moderado. Constatou-se variação entre 52 dB(A) e 68 dB(A) na intensidade da voz das professoras, atingindo 7,48 dB(A) acima do nível do ruído ambiental. Houve correlação entre a intensidade vocal das professoras e ruído ambiental na presença das crianças durante a aula. **Conclusão:** Os níveis de ruído ambiental em sala de aula são altos e se correlacionam com o aumento da intensidade das vozes das professoras. Embora com alta ocorrência de vozes alteradas, não é possível correlacioná-las com o nível de ruído ambiental.

Descritores: Voz; Ruído; Docentes; Disfonia; Percepção auditiva

REFERENCES

1. ABNT- Associação Brasileira de Normas Técnicas. NBR 10152: Níveis de ruído para conforto acústico. Rio de Janeiro, 2000.

2. Nunes MF, Sattler MA. Percepção do ruído aeronáutico em Escolas da zona Ido PEZR do aeroporto internacional Salgado Filho. Engevista. 2005; 6(3):5-24.

3. Pereira TC, Silva IB, Coutinho AS, Oiticica ML. Análise das condições acústicas em sala de aula climatizada de ambiente universitário. XXIV Encontro Nacional de Engenharia de Produção. 2004. Florianópolis.

4. Dreossi RC, Momensohn-Santos T. O Ruído e sua interferência sobre estudantes em uma sala de aula: revisão de literatura. Pró-Fono. 2005;17(2): 251-8.

5. Jaroszewski GC, Zeigelboim BS, Lacerda A. Ruído escolar e sua implicação na atividade de ditado. Rev CEFAC; 2007;9(1):122-32.

6. Batista JB, Carlotto MS, Coutinho AS, Pereira DA, Augusto LG. O ambiente que adoece: condições ambientais de trabalho do professor do ensino fundamental. Cad Saúde Colet. 2010;18(2):234-42.

7. Behlau M, Dragone ML, Nagano L. A voz que ensina: o professor e a comunicação oral em sala de aula. Rio de Janeiro: Revinter; 2004.

8. Libardi A, Gonçalves GO, Vieira TP, Silverio KC, Rossi D, Penteado RZ. O ruído em sala de aula e a percepção dos professores de uma escola de ensino fundamental de Piracicaba. Distúrb Comum. 2006;18(2):167-78.

9. Jardim R, Barreto SM, Assunção AA. Condições de trabalho, qualidade de vida e disfonia entre docentes. Cad Saúde Pública. 2007;23(10):2439-46.

10. Behlau M, Zambon F, Guerrieri AC, Roy N. Panorama epidemiológico sobre a voz do professor no Brasil. Rev Soc Bras Fonoaudiol. 2009:14 (supl.):1511.

11. Luchesi KF, Mourão LF, Kitamura S. Problemas vocais no trabalho: prevenção na prática docente sob a óptica do professor. Saúde Soc [online]. 2009;18(4):673-81.

12. Roy N, Merril RM, Thibeault S, Parsa RA, Gray SD, Smith EM. Prevalence of voice disorders in teachers and the general population. J Speech Lang Hear Res. 2004;47(2):281-93.

13. Simões L, Latorre MR. Prevalência de alteração vocal em educadoras e sua relação com a auto-percepção. Rev Saúde Pública. 2006;40(6):1013-8.

14. Leite MP, Souza NA. Condições do trabalho e suas repercussões na saúde dos professores da educação básica no Brasil – Estado da Arte. Campinas: FUNCAMP; 2007.

15. Penteado RZ, Pereira IM. Qualidade de vida e saúde vocal dos professores. Rev Saúde Pública. 2007:41(2): 236-43.

16. Simões-Zenari M, Bitar ML, Nemr K. Voz de educadoras: relações entre auto-avaliação vocal, aspectos perceptivos auditivos e acústicos e níveis de ruído. Rev Soc Bras Fonoaudiol. 2009:14(supl.):1477.

17. Alves LA, Rambazzi ML, Marziali ML, Felippe AC, Romano CC. Health disorders and teachers' voices: a workers' health issue. Rev Latino-Am Enfermagem. 2009;17(4):566-72.

18. Tapia JA. Contexto, motivação e aprendizagem. In: Tapia JA, Fita EC. A motivação em sala de aula. São Paulo: Loyola; 2004.

19. Gonçalvez CG, Penteado RZ, Silvério KC. Fonoaudiologia e Saúde do Trabalhador: a questão da saúde vocal do professor. Saúde em Revista. 2005;7(15):45-51.

20. Silvério KC, Gonçalvez CG, Penteado RZ, Vieira TP, Libardi A, Rossi D. Ações em saúde vocal: proposta de melhoria do perfil vocal de professores. Pró-Fono. 2008;20(3):177-82.

21. Azevedo LL, Vianello L, Oliveira LG, Oliveira IA, Oliveira BF, Silva CM. Queixas vocais e grau de disfonia em professoras do ensino fundamental. Rev Soc Bras Fonoaudiol. 2009;14(2):192-6.

22. Giannini SP, Ferreira LP, Passos MC. Histórias que fazem sentidos: as determinações das alterações vocais do professor. Distúrb Comum. 2006;18(2):245-57.

23. Dragone ML, Behlau M. A Fonoaudiologia Brasileira e a voz do professor: olhares científicos no decorrer do tempo. Rev Soc Bras Fonoaudiol. 2006;4(2):6-9.

24. Gonçalves VS, Silva LB, Coutinho AS. Ruído como agente comprometedor da inteligibilidade de fala dos professores. Produção. 2009;19(3):466-76.

25. Servilha EA, Ruela IS. Riscos ocupacionais à saúde e voz de professores: especificidades das Unidades de Rede Municipal de Ensino. Revista CEFAC. 2010;12(1):109-14.

26. Lindstrom F, Persson Waye K, Södersten M, MacAllister A, Ternström S. Observations of the relationship between noise exposure and preschool teacher voice usage in day-care center environments. J Voice. 2011;25(2):166-72.

27. ABNT: Associação Brasileira de Normas Técnicas. NBR 10151: Acústica: avaliação do ruído em áreas habitadas, visando o conforto da comunidade: procedimento. Rio de Janeiro; 2000.

28. Hirano M. Clinical examination of voice. New York: Springer Verlag; 1981. p. 81-4.

29. Dejonckere P, Remacle M, Freznel-Elbaz E. Reliability and relevance of differentiated perceptual evaluation of pathological voice quality. In: Clemente MP. Voice Update. Amsterdan: Elsevier; 1996. p. 321-4.

30. Dragone ML, Ferreira LP, Giannini SP, Simões-Zenari M, Vieira VP, Behlau M. Voz do professor: uma revisão de 15 anos de contribuição fonoaudiológica. Rev Soc Bras Fonoaudiol. 2010;16(2):289-96.